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(54) IMPROVEMENTS IN OR RELATING TO VEHICLE COMMUNICATION SYSTEMS

(71) We, THE PLESSEY COMPANY LIMITED, a British Company of 2/60 Vicarage Lane, Ilford, Essex, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to vehicle communication systems and more particularly it relates to a vehicle location monitoring system.

A vehicle location monitoring system according to the present invention comprises a vehicle borne receiving having a data store and having operatively associated with it aerial means, a road a trackside transmitter, the aerial means being inductively coupled with said transmitter for data transfer purposes, a vehicle borne transmitter, a central processor station, adapted to receive signals from the vehicle borne transmitter, the vehicle borne transmitter having operatively associated with it digital code generation means identifying the vehicles and being arranged to transmit such digital code together with the data from the data store corresponding to or derived from data radiated from the road or trackside transmitter and received by the said vehicle borne receiver.

Data transmission by means of an inductive coupling technique as opposed to a radio link utilising an electromagnetic radiation technique has the advantage that data radiation is confined to the vicinity of the transmitting aerial since the radiating range possible with magnetic flux radiation is inherently quite limited. Thus an inductive coupling technique for use in a communication system comprising a plurality of transmitters is especially suitable since the band space which would be required if the medium of electromagnetic radiation were used is not cluttered and problems of interaction between transmitters do not arise especially since the spacing necessary for effective isolation is in practice only a few metres.

The vehicle borne transmitter may be arranged to transmit data directly through the medium of a radio link to the central processor station or it may be arranged to communicate with a road or trackside receiver which communicates with the central processor station over a telephone or similar line link. In the latter case the vehicle borne transmitter may be inductively linked with a road or trackside receiver for data transfer purposes.

Thus as a vehicle monitored by the system passes a road or trackside transmitter it will receive data radiated therefrom indicative of its location and such data is transmitted to the central processor station so that the position of the vehicle as it passes various road or trackside transmitters spaced apart along a route for example and each having a distinctive identification code may be monitored.

The vehicle may be arranged to be in two-way communication with the central processor station. The transmitter in the vehicle may be part of transponder which includes a receiver responsive to an interrogatory code transmitted from the central processor station for initiating transmission from the vehicle to the central processor of certain predetermined data.

The road or trackside transmitter may comprise means for transmitting data at a frequency which is a harmonic or subharmonic of a reference frequency. The data may be carried by a phase modulated carrier, the frequency of which is a subharmonic of a reference frequency radiated from the road or trackside transmitter.

By arranging for the road or trackside transmitter to be inductively coupled rather than electromagneticcaly coupled to the receiver carried by the vehicle, the transmission range is limited to the immediate vicinity of the transmitter so that the data signal transmitted from the road or trackside transmitter is received only by a vehicle as it passes the transmitter.

The roadside transmitter may have opera-

tively associated with it a buried loop aerial which is inductively coupled with the vehicle as it passes over the loop.

The aerial means operatively associated with the vehicle borne receiver may be a ferrite aerial or alternatively it may be a loop aerial.

The vehicle borne receiver is preferably powered locally as by means of a battery thereby avoiding the need for high power transmission from the road or trackside transmitter as would be necessary if such transmission were used to provide power for the apparatus carried by the vehicle.

An exemplary embodiment of the invention will now be described with reference to the drawings accompanying the Provisional Specification in which:

Figure 1 is a block schematic diagram showing a bus carrying a receiver adapted for receiving signals from a beacon unit and for transmitting signals derived therefrom to a central processor station, and in which

Figure 2 is a block schematic diagram showing in greater detail part of the receiver carried by the bus and the beacon unit.

Referring now to Figure 1, it is often desirable to track or monitor the position of each or a fleet of vehicles such as ambulances, buses or taxis, for example, and the present invention seeks to provide a system for achieving this end.

In Figure 1 there is shown schematically a bus which might be one of a fleet of buses each of which carries similar apparatus. The bus shown is arranged to carry a receiver 1 which is coupled to a receiving aerial 2 for receiving data signals radiated from a roadside beacon transmitter 3 via a buried loop aerial 4. The receiving aerial 2 and the buried loop aerial 4 are inductively coupled for data transfer purposes and can be considered as the windings of an air cored transformer. In operation of the system there would be a number of beacon transmitters situated at predetermined locations spaced apart along a route and as the bus passes over or in the vicinity of the beacon a data signal would be received by the receiver carried by the bus indicative of the location of the beacon and hence the location of the bus along the route. Received data is fed from the receiver 1 into a store 5. The store 5 is arranged to feed a transponder 6 which includes a transmitter and a receiver. The transponder 6 is fed also with data from a store 7 which identifies the bus, each bus of the fleet having its own identification code. The transmitter of the transponder 6 is connected to an aerial 8 to facilitate communication with the central processor station 9. The central processor station includes an interrogator transmitter which is arranged periodically to transmit an interrogatory signal which is received by the receiver of the transponder 6 and which initiates transmission of data from the stores 5 and 7 to indicate the location of the bus. When a fleet of buses or other vehicles are arranged to carry a system according to the invention, they may be interrogated sequentially on a time sharing basis, their location or approximate location being indicated by the data carried in the store 5 which is fed to the transmitter of the transponder 6. Although in the present example communication with the central processor station is through the medium of a radio link, it may be arranged that the transmitter is inductively coupled to a roadside receiver, the roadside receiver being connected by a line communication link to the central processor station. Although the present system is particularly suitable for identifying the location or approximate location of the bus, other data may be transmitted relating for example to the route to be taken by the bus or the speed of the bus, or in the case of automatic or semi-automatic vehicle systems, to initiate operation of, or to indicate the initiation of operation of secondary systems such as doors, vent flaps and so on. Similarly, the data carried in the identification code store 7 may in addition to identifying the bus indicate its expected route, or direction of journey, and/or final destination, crew identification and or other data as may be required in accordance with the particular application in view. The apparatus carried by the bus would normally be powered by a battery or generator carried by the bus whereas the beacon transmitter 3 would normally be powered by a mains supply or similar source. The signals radiated from the beacon transmitter would typically comprise an unmodulated reference signal and a data signal which might be a sub-multiple or multiple of the reference signal and which might typically be half the frequency of the reference signal and be phase modulated with 180° phase modulation to provide a binary coded signal.

Turning now to Figure 2, the vehicle receiver unit 1 and beacon unit 3 are shown in greater detail. The beacon unit comprises a reference generator 10 generating a reference frequency F which is fed on the one hand to a loop transmitting aerial 11 and on the other hand to a divider circuit 12 operating to afford a division factor A. The divider circuit 12 feeds a second divider circuit 13 which operates to afford a division factor B and which provides at its output a frequency on line 14 of $\frac{F}{AB}$ which is used as a clock frequency to clock data from a message generator 15. The data signals from

the message generator are fed on line 16 to a 180° phase modulator 17 to modulate appropriately a carrier frequency of $\frac{F}{A}$ which is fed on line 18 from the divider circuit 12. The phase modulator provides at its output a carrier frequency of $\frac{F}{A}$ phase modulated with data and fed to the transmitter loop aerial 11 on line 19.

The vehicle receiver unit comprises a loop receiving aerial 20 which might alternatively be a ferrite aerial or a frame aerial which receives on the one hand the reference frequency which is fed to a divider circuit 21 having a division factor AB and on the other hand to a divider circuit 22 having a division factor A. The aerial also receives the carrier frequency $\frac{F}{A}$ phase modulated with data and this signal is fed on line 23 to a phase demodulator 24 which is fed also via line 25 with a frequency of $\frac{F}{A}$ from the divider circuit 22. The output from the phase demodulator 25 is fed on line 26 to a data transition recognition circuit which provides output pulses consequent upon reception of transitions from 0 to 1 and vice versa in the data and which feeds the divider circuit 21 to initiate the transmission of sync pulses at a frequency of $\frac{F}{AB}$ on line 27. An output signal from the phase demodulator is also fed via a start-of-message recognition circuit 28 to gate the divider circuit 22. Thus it will be appreciated that if the data signal on line 28 is clocked with or gated by the sync pulses on line 27, then a data output signal will be produced corresponding with the data signal transmitted from the beacon unit. A block circuit diagram almost identical to the vehicle receiver unit and beacon unit just before described is described in somewhat greater detail in our G.B. Patent No. 1187130, to which attention is hereby directed, but whereas in the present system the beacon unit is mains powered and includes a pulse generator for derivation of a clock signal transmission, the system as described in our G.B. Patent No. 1187130 includes a responder unit which corresponds to the beacon unit but which is powered by received energy radiated from an interrogator unit corresponding to the vehicle borne receiver unit, the signal radiated from the interrogator for power supply purposes being used both in the interrogator and in the responder unit for derivation of a clock signal. Thus whereas in the system described in our G.B. Patent No. 1187130 the signal from which the clock is derived is operated in the interrogator unit corresponding to the receiver unit of the present system, in the present system the signal from which the clock is derived is generated in the beacon unit. It will therefore be appreciated that the advantages of high noise immunity associated with systems having a discrete clock signal are retained in the present system.

WHAT WE CLAIM IS:—

1. A vehicle location monitoring system comprising a vehicle borne receiver having a data store and having operatively associated with it aerial means, a road or trackside transmitter, the aerial means being inductively coupled with said transmitter for data transfer purposes, a vehicle borne transmitter, a central processor station adapted to receive signals from the vehicle borne transmitter, the vehicle borne transmitter having operatively associated with it digital code generation means identifying the vehicle and being arranged to transmit such digital code together with data from the data store corresponding to or derived from data radiated from the road or trackside transmitter and received by the said vehicle borne receiver.

2. A vehicle location monitoring system as claimed in claim 1 wherein the vehicle borne transmitter is adapted to transmit data through the medium of a radio link.

3. A vehicle location monitoring system as claimed in claim 1 wherein the vehicle borne transmitter is inductively linked with a road or trackside receiver for data transfer purposes.

4. A vehicle location monitoring system as claimed in claim 2 wherein the vehicle borne transmitter forms a part of a transponder which includes a receiver responsive to an interrogatory code transmitted from a central processor station for initiating transmission from the vehicle to the central processor station of predetermined data.

5. A vehicle location monitoring system as claimed in any preceding claim wherein the road or trackside transmitter comprises means for transmitting data at a frequency which is a harmonic or sub-harmonic of a reference frequency.

6. A vehicle location monitoring system as claimed in claim 5 wherein the data is carried by phase modulated carrier, the frequency of which is a sub-harmonic of the reference frequency.

7. A vehicle location monitoring system as claimed in any of claims 4, 5 or 6 wherein the road or trackside transmitter has operatively associated with it a buried loop aerial which is inductively coupled with a vehicle as it passes in the vicinity of the buried loop aerial.

8. A vehicle location monitoring system

as claimed in any preceding claim wherein the aerial means operatively associated with the said vehicle borne receiver is a loop aerial.

9. A vehicle location monitoring system as claimed in any of claims 1 to 7 wherein the aerial operatively associated with the said vehicle borne receiver is a ferrite aerial.

10. A vehicle location monitoring system substantially as hereinbefore described with reference to the drawings accompanying the Provisional Specification.

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1543 910 PROVISIONAL SPECIFICATION
2 SHEETS

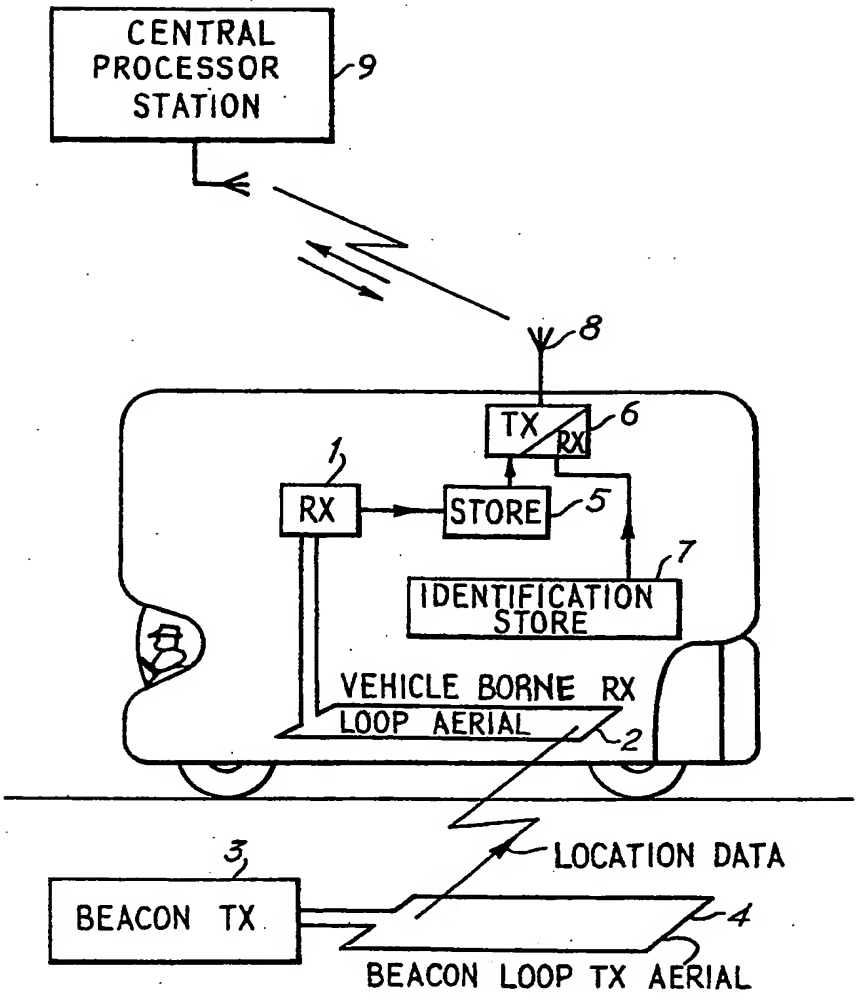

FIG. 1

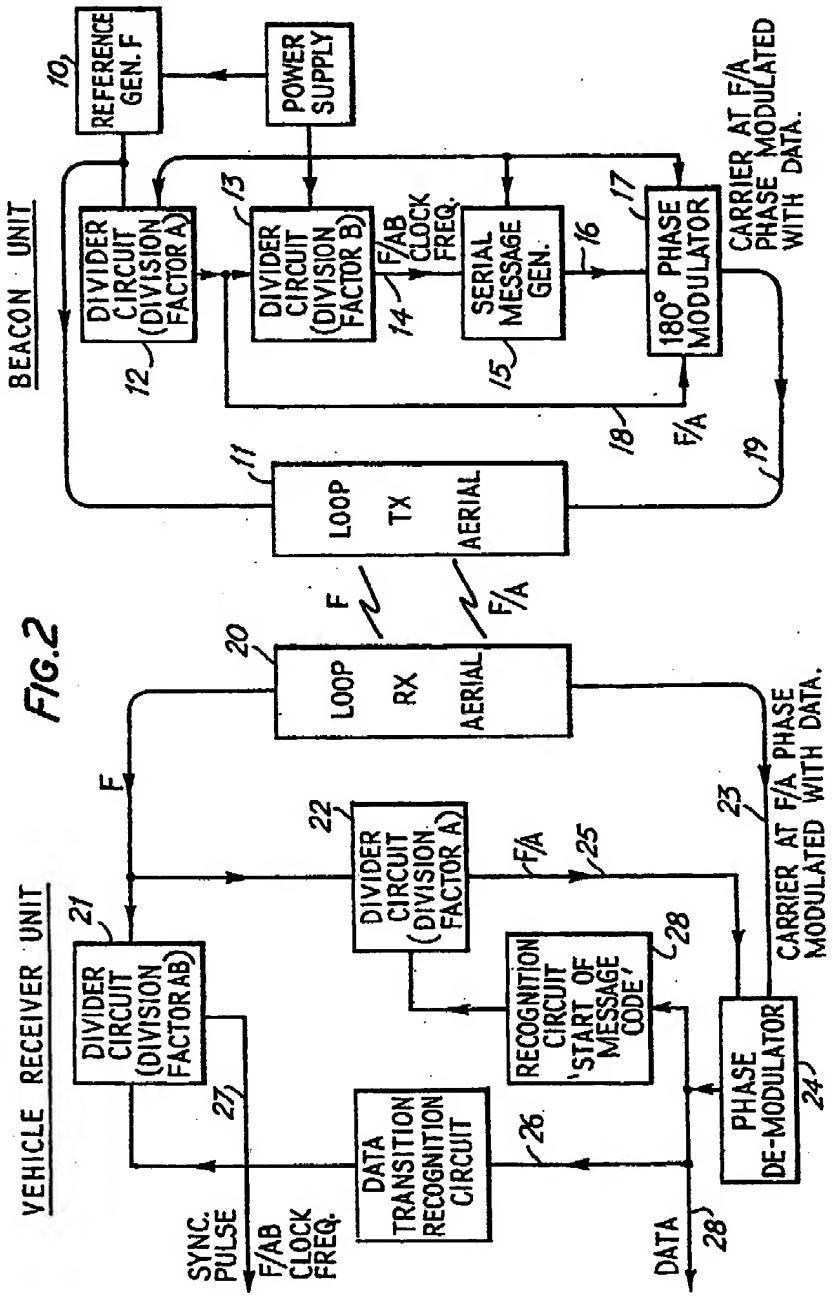
BEACON UNIT
REFERENCE GEN. F
10
POWER SUPPLY
DIVIDER CIRCUIT (DIVISION FACTOR A)
12
DIVIDER CIRCUIT (DIVISION FACTOR B)
13
F/AB CLOCK FREQ.
14
SERIAL MESSAGE GEN.
15
16
180° PHASE MODULATOR
17
CARRIER AT F/A PHASE MODULATED WITH DATA.
18
F/A
19
LOOP TX AERIAL
11
F
F/A
LOOP RX AERIAL
20
CARRIER AT F/A PHASE MODULATED WITH DATA.
23
VEHICLE RECEIVER UNIT
DIVIDER CIRCUIT (DIVISION FACTOR A)
22
F/A
25
DIVIDER CIRCUIT (DIVISION FACTOR AB)
21
RECOGNITION CIRCUIT 'START OF MESSAGE CODE'
28
PHASE DE-MODULATOR
24
DATA TRANSITION RECOGNITION CIRCUIT
26
27
SYNC. PULSE
F/AB CLOCK FREQ.
DATA
28

FIG.2